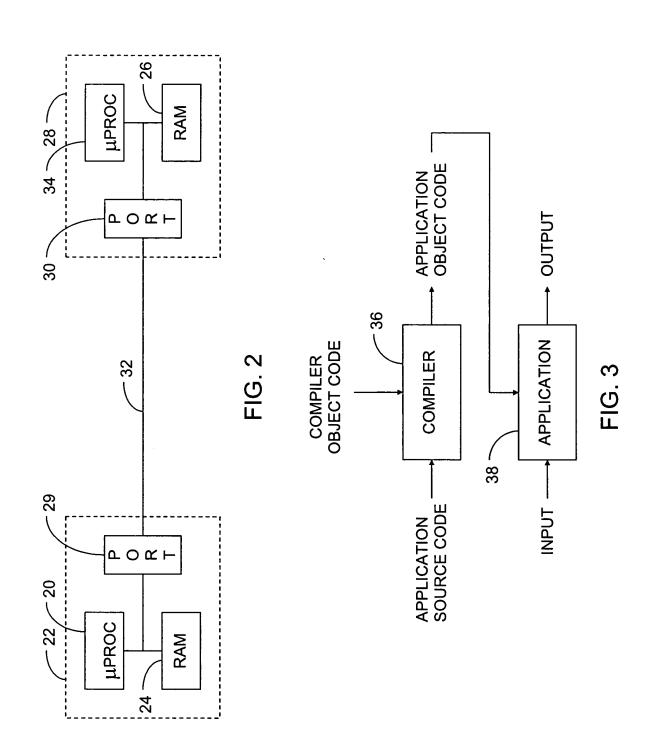
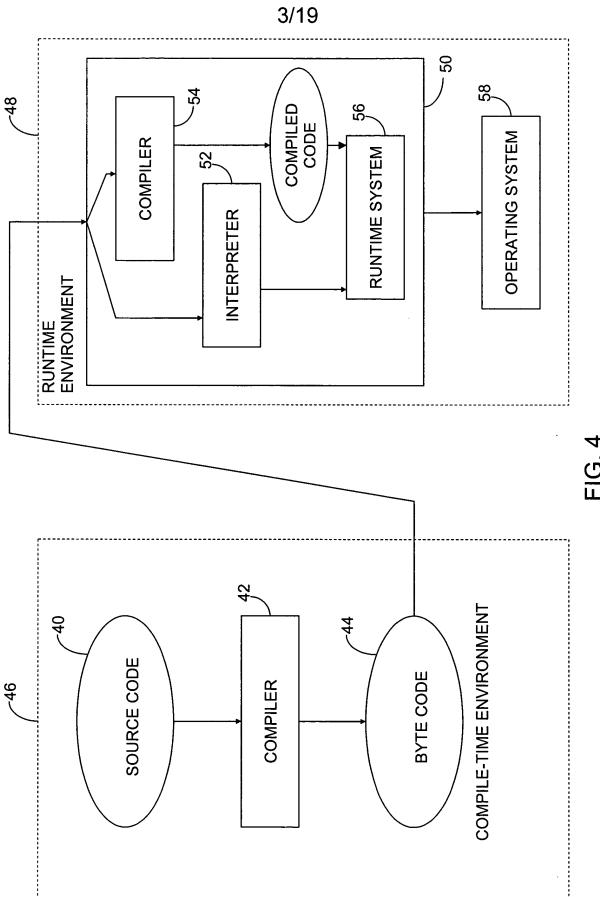


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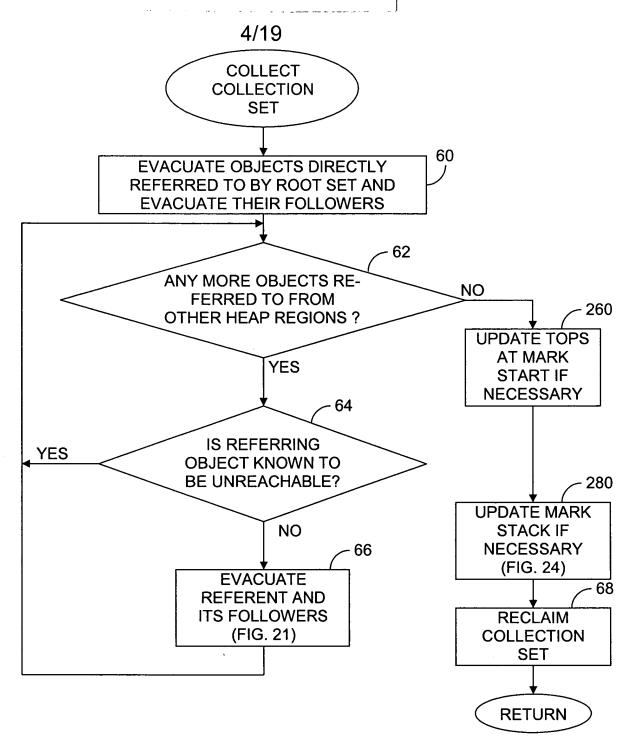
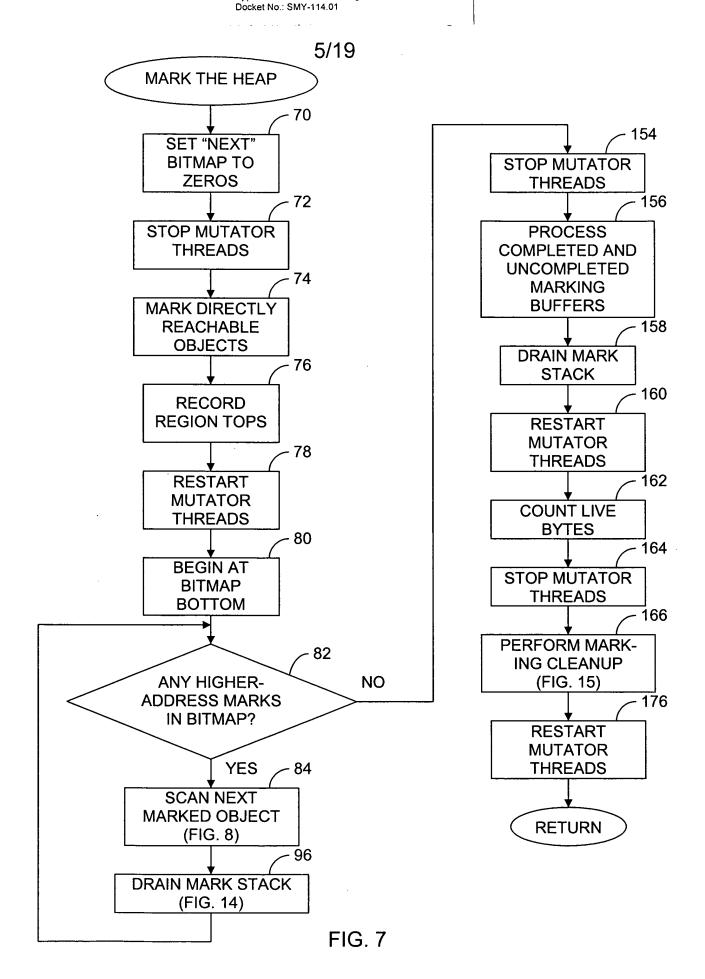


FIG. 5



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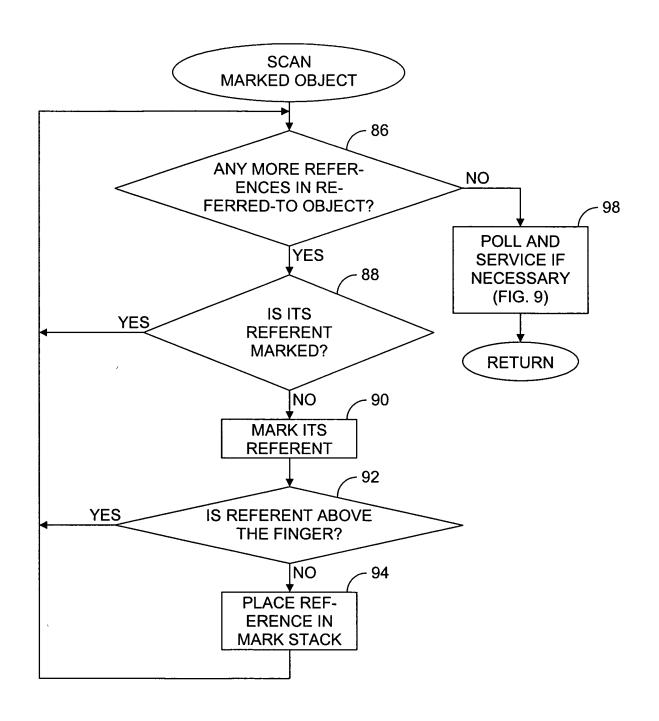


FIG. 8

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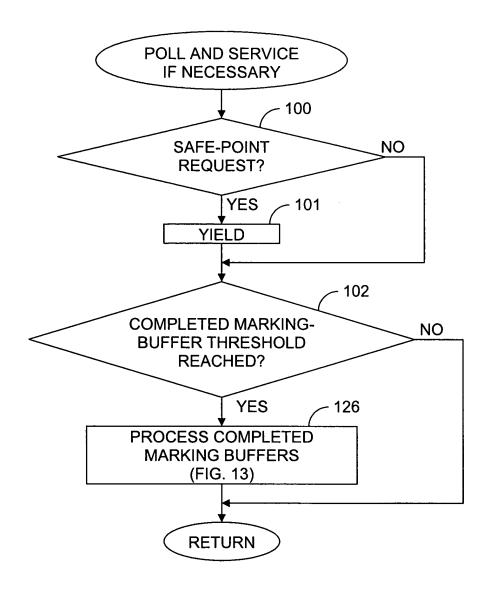
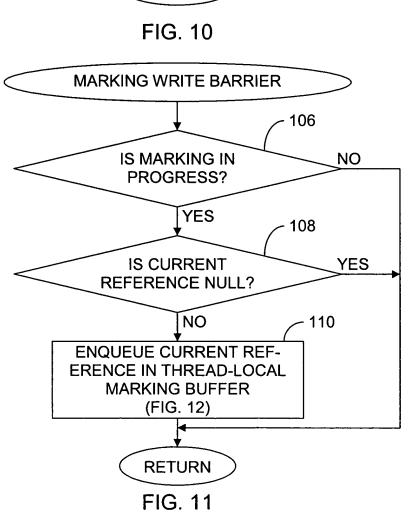


FIG. 9

Title: Exploiting Popular Objects to Reduce Mutator Overhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01 8/19 **WRITE** REFERENCE 104 MARKING WRITE BARRIER (FIG. 11) 124 REPLACE OLD REFERENCE WITH **NEW REFERENCE** - 178 REMEMBERED-SET WRITE BARRIER (FIG. 16) **RETURN** FIG. 10 MARKING WRITE BARRIER 106 IS MARKING IN NO PROGRESS? YES 108 IS CURRENT YES



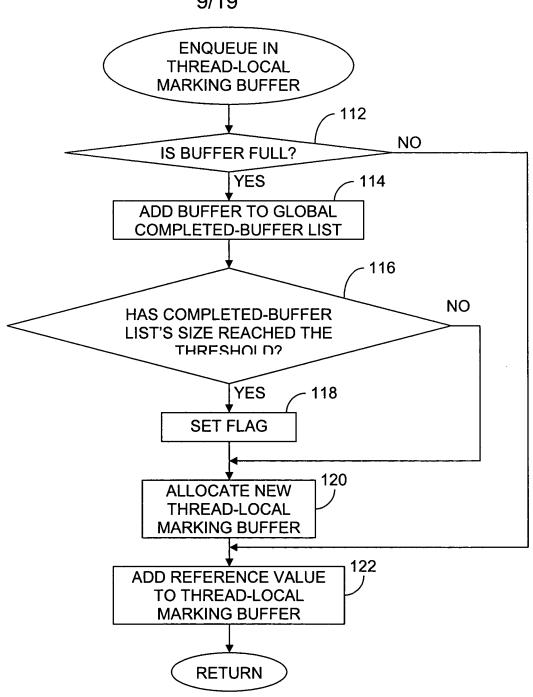


FIG. 12

Inventor(s): David L. Detlefs
Application No.: Not Yet Assigned
Docket No.: SMY-114.01 10/19 PROCESS COMPLETED MARKING BUFFERS - 128 ANY COMPLETED NO **RETURN BUFFERS LEFT?** 130 YES **CONSIDER NEXT BUFFER** 132 ANY ENTRIES LEFT IN NO **COMPLETED BUFFER?** YES 134 **CONSIDER NEXT REFERENCE** 136 IS REFERENT YES MARKED? 138 NO **MARK** REFERENT 140 YES IS REFERENT **ABOVE FINGER?** NO - 142 **PLACE** REFERENT IN MARK STACK FIG. 13

Title: Exploiting Popular Objects to Reduce Mutator Overhead

Mutator Overhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01 11/19 **DRAIN MARK STACK** 146 ANY MORE REFER-NO **ENCES IN MARK RETURN** STACK? YES 148 **CONSIDER** NEXT' REFERENCE - 150 **SCAN ITS** REFERENT (FIG. 8) **PERFORM MARKING CLEANUP** FIG. 14 168 **COMPLETE LIVE-BYTE COUNT** 170 FREE GAR-**BAGE-ONLY REGIONS** 172 **SORT REGIONS BY EFFICIENCY** - 174 **SWAP PREVIOUS** AND NEXT BITMAPS

RETURN

FIG. 15

Title: Exploiting Popular Objects to Reduce

Title: Exploiting Popular Objects to Reduce Mutator Overhead Inventor(s): David L. Detlefs

Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01

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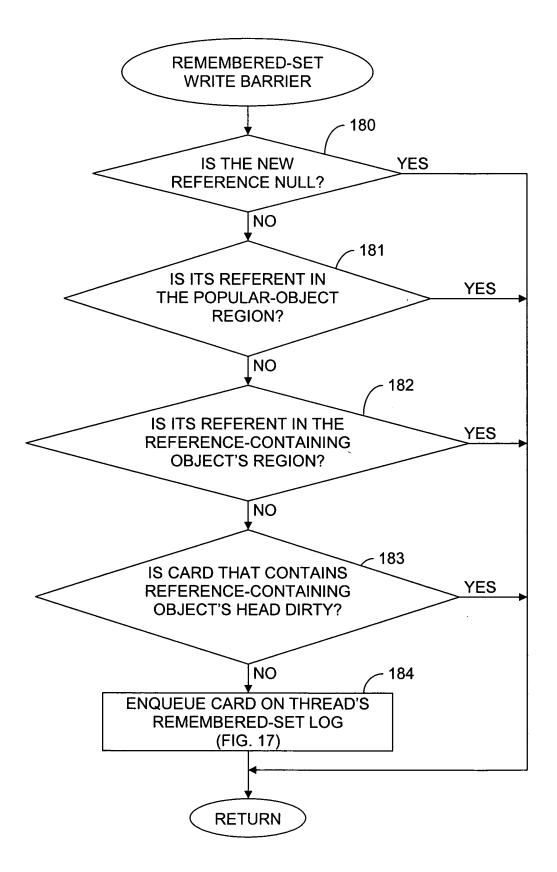


FIG. 16

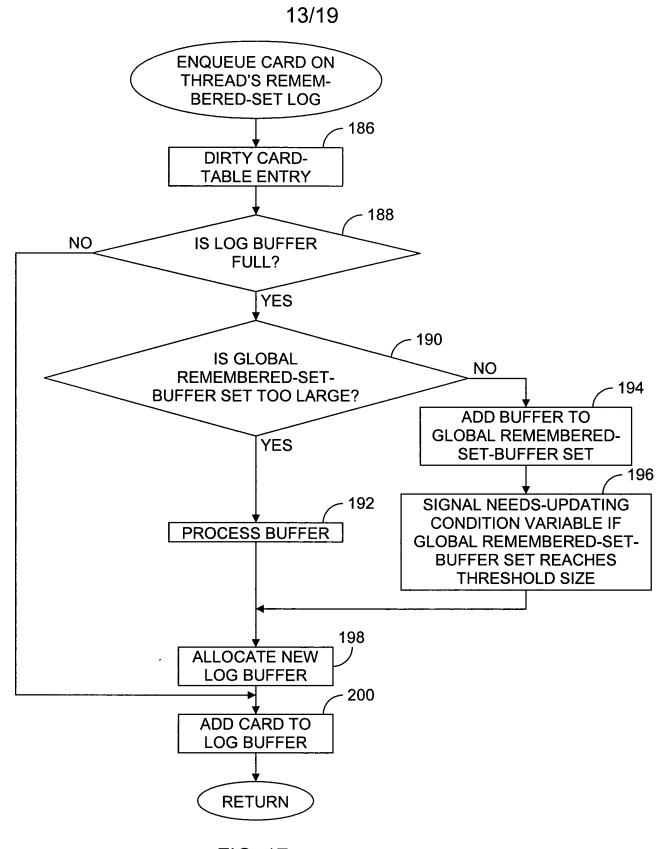


FIG. 17

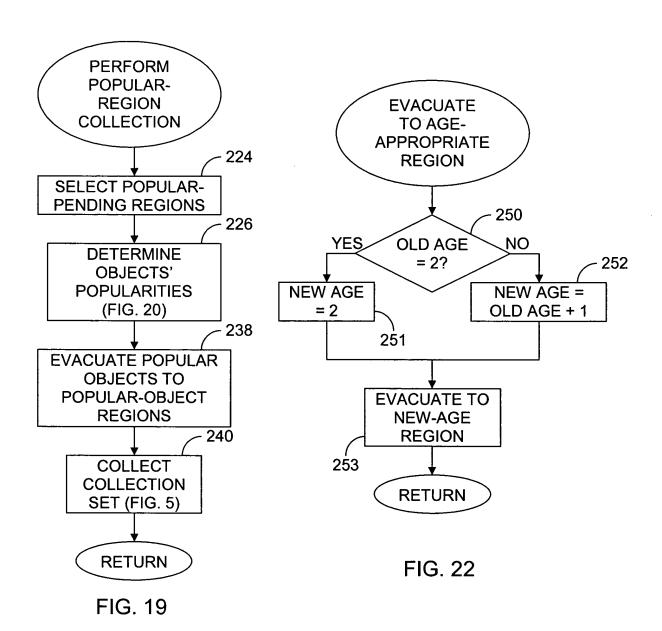
Mutator Overhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01 14/19 **UPDATE** REMEMBERED SETS CONCURRENTLY 204 NO **ANY BUFFER RETURN ENTRIES LEFT?** - 206 YES 212 RESET NEXT ENTRY **SET ENTRY** TO "CLEAN" TO "DIRTY" 208 **SCAN FOR NEXT** REFERENCE 210 **WAS SCAN** NO SUCCESSFUL? YES - 214 **ANY REFERENCE** NO LEFT? YES 216 IF NECESSARY, ADD REFERENCE'S ADDRESS TO (THREAD-SPECIFIC) REMEM-BERED SET AND INCREMENT ITS **ENTRY COUNT** 218 DOES REMEMBERED SET'S EN-NO TRY COUNT EXCEED THE POPU-LARITY THRESHOLD? YES 220 ADD REGION TO POPULAR-**PENDING LIST** FIG. 18

Title: Exploiting Popular Objects to Reduce

Title: Exploiting Popular Objects to Reduce

Mutator Overhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01

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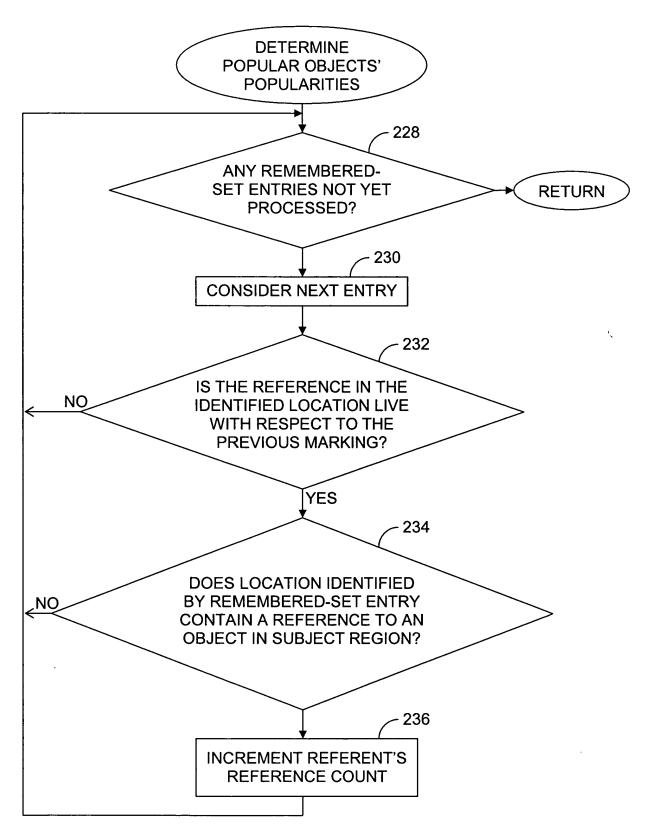


FIG. 20

17/19 **EVACUATE OBJECT AND FOLLOWERS** - 242 HAS OBJECT YES ALREADY BEEN **EVACUATED?** NO - 248 **EVACUATE TO AGE-**APPROPRIATE REGION (FIG. 22) - 244 256 **UPDATE REFER-ENCE AND ADD TO UPDATE REFER-**REMEMBERED SET **ENCE AND ADD TO** REMEMBERED SET 258 APPRISE MARKING **THREADS** (FIG. 23) - 274 DOES OBJECT CONTAIN NO ANY MORE REFERENCES TO **COLLECTION-SET OBJECTS** YES - 276 **EVACUATE REFERENT** AND FOLLOWERS (FIG. 21) **RETURN** FIG. 21

Title: Exploiting Popular Objects to Reduce

Mutator Överhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01

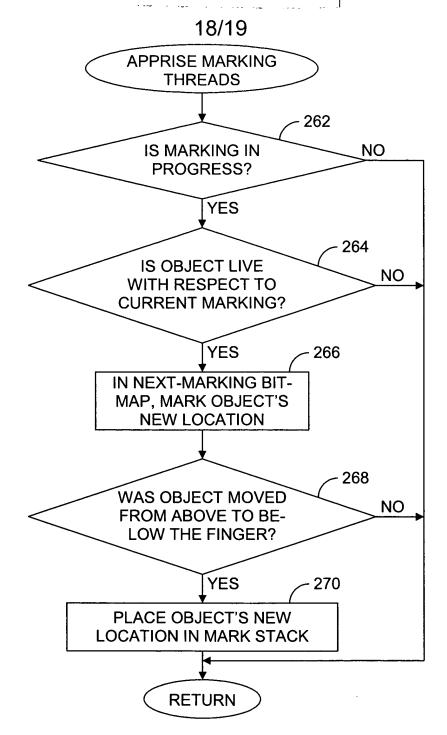


FIG. 23

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Title: Exploiting Popular Objects to Reduce Mutator Overhead Inventor(s): David L. Detlefs Application No.: Not Yet Assigned Docket No.: SMY-114.01 19/19 TRIGGER MARKING IF NEEDED 300 **CONSIDER NEXT REGION** 302 $g = a_{top} - a_{bot} - n_{evac}$ 304 **ARE ANY MORE** YES **COLLECTION-SET REGIONS LEFT?** - 306 ŃΟ $G_{old} = G_{new}$ $G_{new} = G_{old} + g$ FIG. 24 $T_{new} = T_{old} + t$ 308 **HAVE ENOUGH** NO **COLLECTION INCRE-MENTS OCCURRED?** YES 310 $\frac{G_{new}}{=} < \frac{G_{old}}{=}$? NO T_{new} YES - 312 REQUEST MARKING RETURN